THE BRITISH VETERINARY JOURNAL

EDITORS:
T. DALLING, *M.A., M.R.C.V.S.* J. McCUNN, *M.R.C.V.S., L.R.C.P.*

Vol. 105 **February, 1949** **No. 2**

EDITORIAL

ANIMAL HUSBANDRY and PREVENTIVE MEDICINE

In this issue of The British Veterinary Journal there appears an article dealing with the subject of Animal Husbandry. Veterinarians are well aware of the part played by animal husbandry in the maintenance of healthy livestock. It may be difficult at times to appreciate its influence, but as study and observations proceed the linkage is becoming clearer. The question of producing food of a suitable kind and in sufficient quantity to meet the growing needs of livestock in this country is exercising the minds of responsible organisations. In dealing with hill-sheep, for example, it is not too severe a criticism to say that at certain periods of the year there exists a state of almost semi-starvation which influences, to a marked extent, the well-being of the flocks. At times when there is most need for an abundance of food, e.g., during parts of the period of pregnancy, there is often a severe scarcity of natural food and one wonders how the sheep survive; but not only do they survive, they also produce lambs. It is true that improvements have been and are being made whereby more natural food is available and reserves of feedingstuffs are preserved for these hard times. Further improvements are, however, necessary not only for existing stock but also for increases in the stock-carrying capacity of some of our hill land. Agronomists and other scientists interested in this problem are devoting much time to the study of hill land improvement and to the breeding and cultivation of grasses suitable for sheep on the mountains and hills: in addition, attention is being given to the development of methods of ensilage and grass drying, so that reserves of food will be available.

While the provision of more food is an important problem, we must keep before us the influence that new methods of food production may have on the health of the livestock receiving that food. There is need for close team work, in which the veterinarian has a big part to play, in the study of alterations in

types of animal husbandry, including feeding. We read from time to time of alleged associations between new leys and the appearance of diseases of cattle, e.g., an increase in the incidence of bloat, infertility, etc. Such reports are apt to be misleading in the absence of definite proof, based on the carrying out of well-planned experiments and the analysis of the experimental data. The joint efforts of various kinds of workers are essential in such studies.

Some methods now in operation for the prevention of diseases of livestock have to be regarded as temporary measures to deal with the situation until such times as improvements and alterations can be made in the types of husbandry. The methods in use at present are serving their purpose well, but their replacement by new husbandry with, we expect, beneficial results to health, will probably be but a matter of time. Those of us who took part in the devising of some of the present-day methods of control of sheep diseases, for example, realised fully that, while we were saving lives and improving health by the measures adopted, it was highly probable that further study would lead to simpler methods of control by the practice of new types of husbandry.

Husbandry methods in the control of disease are well shown in the suppression of parasitic gastritis in sheep. A study of the life history and conditions of development of the causal parasites has shown very clearly how the grazing of sheep can be so regulated over pastures that a minimum of worm infestation takes place. The variation in the susceptibility of different types of livestock to different species of internal parasites is also made use of in controlling this disease: the grazing of different kinds of stock on the same pasture is the result of such observations; more recent work concerns the control of liver fluke infestation in sheep and cattle. A study of the habits of the intermediate snail host is showing the areas where the snails are most likely to breed and the conditions under which they thrive. While good results follow preventive and curative treatment of sheep, the aim must also be to alter methods of husbandry whereby the conditions for the survival of the snail are made unsuitable and so to reduce the numbers or rid the pastures of fluke.

Animal husbandry embraces many subjects. The hygiene practised in milk production comes under the term. Here we have an excellent example of how that disease of such economic importance—mastitis—can be well controlled by the carrying out of good hygiene measures in the cowsheds and milking premises. Coupled with suitable treatment of the udder, teats, etc., of infected cows, the adoption of such measures is being shown to reduce the incidence of mastitis in some of its forms to a very marked extent.

These few examples indicate how animal husbandy may influence the occurrence of disease and how, in much of our disease work, more and more attention has to be given to the subject. Animal husbandry occupies an important place in the teaching carried out in our veterinary schools. Its importance cannot be stressed too much, and it is hoped that every opportunity will be taken to continue and expand research work on animal husbandry in all its various aspects, so that our knowledge of its association with the health of livestock will increase and simpler methods of control of some diseases will be the result.

GENERAL ARTICLES

STUDIES ON EQUINE PURPURA HÆMORRHAGICA

Article No. 3—Morbid Anatomy and Histology

By A. S. KING, B.Sc.(Vet. Sci.), M.R.C.V.S.

Department of Anatomy, Royal Veterinary College

Introduction

THIS paper, which is the third in the series submitted from the Royal Veterinary College dealing with equine purpura hæmorrhagica, is based on an investigation into the morbid anatomy and histology of five cases of equine purpura. These five cases were those of horses B, C, D, E and G.*

For the three following reasons a fairly full report of the observations has been published: first, because we believe it desirable that the reader should be enabled to judge for himself the degree to which the cases examined were typical of purpura; secondly, because in the course of a review of the literature undertaken at the beginning of this investigation, no comprehensive account of both the morbid anatomy and histology was encountered (personal communication from J. D. Biggers and P. L. Ingram); thirdly, because a full account of the morbid anatomical and histological findings is found to provide a useful means of checking any hypotheses put forward to account for the pathogenesis.

We wish to place on record our regret that circumstances made it impossible for the Department of Pathology, Royal Veterinary College, to undertake this part of the investigation into equine purpura hæmorrhagica.

Material

Five cases, namely, horses B, C, D, E and G, were examined post-mortem during the course of the investigation. Horses C and G had been under more or less regular clinical observation from the day when purpura was first diagnosed up to the time of death; horse B was examined once before death. Horses D and E were both destroyed before any clinical examination could be made. All five cases were heavy draught horses.

In addition, a sixth heavy draught horse, also from the L.M.S. stables, developed purpura during the spring of 1948 and died after the disease had run a typical course. Since further material was particularly required to assist in the elucidation of the morbid histological changes which occur in the skeletal musculature in equine purpura, use was also made of this horse. This case was subsequently known as horse H.

Methods

The post-mortem examinations were carried out at the knacker's yard as soon after death as was possible. Unfortunately, although all the examinations

* Six cases of equine purpura were examined during the course of this investigation, which were given the index letters B, C, D, E, F and G. Detailed information concerning the fate of these horses, and including the clinical records of horses B, C and G, is available in the second article of the series, namely, SYMPTOMATOLOGY (Bennett and King, 1948).

were made on the same day as that on which death occurred, on several occasions a considerable number of hours elapsed before the examination was performed and also, therefore, before the commencement of fixation of tissues required for histological purposes. Consequently the interpretation of some of the sections which were ultimately obtained had to be undertaken with considerable reserve. This point will receive further emphasis below.

All the material obtained from horses B, C, D, E and G was fixed in Bouin's fluid. The pieces of skeletal musculature taken from horse H were fixed variously in Bouin, Susa, formol-saline and Zenker-formol.

Paraffin wax was used as the embedding medium.

The great majority of the sections were stained with Ehrlich's hæmatoxylin and eosin, and in the account of the morbid histological findings it should be assumed that this method of staining was used, unless specific information is given to the contrary, Ehrlich's hæmatoxylin and van Gieson's stain were employed on a few sections to show collagen. The Prussian blue reaction was used, when necessary, to test for the presence of iron.

All the above techniques, namely, of fixing, embedding and staining, were carried out by the methods recommended by Carlton and Leach (1938).

For the staining of some of the sections showing hæmorrhagic lesions in the skeletal musculature a modified Masson method was used, which is basically similar to the Hæmatoxylin-Ponceau-Fuchsin-Light Green method of Masson described by Carlton and Leach (1938). It differs in that eosin is used instead of the Ponceau-Acid Fuchsin. This method stains the cytoplasm green, nuclei blue, and erythrocytes a deep red. It therefore makes the detection of hæmorrhage easier, and for this reason we found the method useful.

Morbid Anatomical and Histological Findings

Unless specific information is given to the contrary in the account below of the findings in the various organs, it should be taken that a histological examination was not made.

Horse B.

Horse B was a gelding, and was about six years old. It died from purpura after the disease had lasted about fourteen days. The following examination was commenced about twelve hours after death, on February 1, 1947. Unfortunately the body had been completely dismembered by the knackers before the examination began.

Skin.—There were a number of diffuse dark-red hæmorrhagic areas in the subcutaneous tissues.

Skeletal Musculature.—Most of the skeletal musculature showed very numerous and conspicuous reddish-black lesions, generally oval or spherical and about one inch in diameter. These lesions were not always apparent on superficial inspection of the muscles, but were readily discovered in every muscle which was cut open.

Section material was prepared from these lesions for histological examination. Extensive degeneration of the muscle fibres was observed, which appeared to take place in a number of distinguishable stages; predominantly there was

swelling and rupture of the fibres with copious hæmorrhage around the fragments. Further details will be presented in the discussion under the heading *Lesions in the Skeletal Musculature.*

Omentum.—The omental vessels were congested and the colour of the organ as a whole was a deep purple-red.

Abdominal Viscera.—No macroscopic abnormality was observed in the gastro-intestinal tract and its associated glands, nor in the urino-genital system.

The spleen was the only organ examined histologically. Areas of brown granules were seen, which gave a negative response to the Prussian blue reaction. Their nature remains uncertain, but they may have been formed through the action of formalin on iron-containing compounds.

Thoracic Viscera.—No macroscopic abnormality was observed.

Bone Marrow.—The femur on one side was split open and examined macroscopically. No abnormality was observed.

Intermaxillary Abscess.—This abscess was examined cursorily and found to be a suppurative area about the size of a fist.

Horse C.

Horse C was a mare, and was about eight years old. It was destroyed on February 21, 1947, by the intravenous injection of chloral hydrate, after purpura had lasted for twenty-one days. The following post-mortem examination was commenced immediately after death.

Skin.—Some parts of the surface of the body showed slight œdematous swellings. On removal of the skin, it was seen that there was no definite petechiæ or ecchymoses in the subcutaneous connective tissue. There were, however, two or three very small areas which might have been the sites of old hæmorrhages. There was a considerable degree of subcutaneous œdema, particularly over the ventral aspect of the trunk; after incision of the skin a clear yellow œdema-fluid trickled from the subcutaneous tissues. A sample of this fluid was taken for biochemical examination (see discussion under the heading *The Œdema*).

Skeletal Musculature.—After a searching scrutiny, the greater part of the skeletal musculature was found to be normal. Only a few very diminutive reddish-black lesions were seen and they were confined to the pectoral muscles and the ventral muscles of the neck.

No histological material was prepared as the lesions appeared similar to those already seen in horse B.

Peritoneal Cavity.—There was no significant quantity of fluid in the peritoneal cavity.

Gastro-intestinal Tract.—Throughout the length of the gastro-intestinal tract the only abnormality observed was a small pale-red discoloration on the serous coat of the duodenum.

Liver.—Apart from two small adhesions to the diaphragm, the liver was apparently normal.

Spleen.—Macroscopically, the spleen was normal.

Microscopically, granules were seen which appeared similar to those described in horse B. The Prussian blue reaction was not employed.

XUM

Kidneys.—The kidneys appeared normal.

Adrenal Glands.—The surfaces of both adrenals were irregularly elevated into white nodules which varied in diameter from about 1 mm. to 5 mm. The smaller nodules were discrete and well defined.

On histological examination the nodules appeared as small glandular areas isolated by the connective tissue of the capsule from the rest of the gland tissue. The cells of the nodules seemed to be similar to those of the zona glomerulosa. The medulla was normal.

Urinary Bladder.—The bladder was apparently normal. It was empty; micturition had occurred immediately before death.

Lungs.—There were several areas of lobular congestion on the surfaces of both lungs. In some regions, chiefly in the apices, there were great numbers of abscesses about the size of a pin's head. On the edge of the apex of one lung there were three or four larger abscesses, about 5 mm. in diameter, which contained inspissated pus. There were a few areas of emphysema.

Sections were prepared from areas of lung taken at random. No abscesses or other well-marked lesions were found on histological examination. In a few areas, however, the alveoli contained a red-staining, non-cellular material, which, since it was free from cells, was thought to be œdema-fluid.

Heart.—The heart was apparently normal.

Horse D.

Horse D was a gelding, and was about seven years old. It was destroyed by shooting on February 1, 1947, after purpura had lasted a number of days. The railway authorities ordered destruction for humane reasons before a clinical inspection could be made. The following post-mortem examination was commenced four hours after death, but an additional period of about the same duration elapsed before all the specimens obtained were fixed in preparation for sectioning.

Skin.—Examination of the surface of the body showed that there were very large swellings over the preputial region and the region of the right thigh. In some of these areas the skin was beginning to slough. On removal of the skin of the pectoral and ventral abdominal regions it was seen that there was marked subcutaneous œdema, especially near the prepuce, with numerous ecchymoses.

Histological sections were prepared and examined, but apart from the presence of œdema no significant changes were noted. (The region of the slough was not examined.)

Skeletal Musculature.—A few of the reddish-black lesions described above in the case of horse B were found. Compared with horse B, however, taking the skeletal musculature as a whole they were much less numerous.

Owing to the macroscopic similarity to the lesions in horse B, no histological material was prepared.

Peritoneal Cavity.—The peritoneal cavity contained a considerable quantity of clear yellow fluid. About two litres were collected and sent for biochemical

examination; during the course of collection the fluid was slightly contaminated with blood from the dissection.

Omentum.—The omentum appeared normal.

Gastro-intestinal Tract.—Numerous ill-defined areas of red discoloration were present on the serous surface of the small and large intestines. The size of these areas varied greatly, the largest being several inches in diameter. The mucous membrane, both beneath these areas and elsewhere, was apparently normal. There was a generalised venous congestion of the splanchnic vessels.

Liver.—Macroscopically, the surface and substance of the liver appeared normal.

Histological examination showed that there were signs of cloudy swelling, which could have been due to post-mortem changes.

Spleen.—The surface of the spleen was speckled with numerous petechiæ. No abnormality of the deeper tissues was noted.

Histological examination showed crystals similar to those in the spleen of horse B and horse C. Sections tested for the Prussian blue reaction gave a negative result.

Kidneys.—Macroscopic inspection of the surface and deeper regions of the kidneys revealed no abnormality.

Histological examination, however, showed that considerable changes had taken place. The secretory tubules contained a diffuse, poorly-staining debris and a few clumps of cells which were thought to be desquamated epithelial cells. The smaller excretory tubules, passing radially through the medulla, contained a few scattered cells, similar to those seen in the secretory tubules, and masses of a homogeneous material; this material showed a pink hyaline-like staining reaction. The larger excretory tubules, of which only a few were visible on the sections, contained debris which consisted chiefly of cells similar to those described above, but which also contained occasional groups of small yellow objects closely resembling erythrocytes. In some areas there was degeneration and even complete disintegration of the tubular epithelium; undoubtedly this could have been partly due to delay in fixation. In between the tubules there were fairly numerous patches of hyaline-like pink-staining material. The glomeruli were more nearly normal, but similar hyaline-like material was observed in a few. There was a marked hyperæmia of the medulla. No free hæmorrhage was found anywhere. There was no apparent increase in the number of intertubular cells. Van Gieson's stain showed no abnormality in the distribution of collagen. Unstained sections were made to investigate further the nature of the intratubular material. It was found that the debris in the secretory tubules and the smaller excretory tubules was not coloured in the absence of stain. Unfortunately, the larger excretory tubules were not present on these unstained sections.

Urinary Bladder.—No macroscopic structural abnormalities were found. About half a litre of urine, which was yellow in colour and very thick, was found inside the bladder. A sample was sent for biochemical examination; the result of this examination receives comment in the discussion under the heading, *The Possibility of Renal Failure.*

Lungs.—There were regions in both lungs of purulent broncho-pneumonia, showing purulent exudate in the bronchial tree and, notably in the apices, numerous abscesses about one cm. in diameter.

In the sections examined histologically, no abscesses were found, but many of the alveoli and some of the bronchioles contained a red-staining material. This material contained only a few cells which, almost invariably, were erythrocytes. The material was thought to be, at least partly, œdema-fluid.

Heart.—No abnormality was discovered.

Horse E.

Horse E was a gelding, and was about eight years old. It was destroyed by shooting on February 1, 1947. As in the case of horse D, the animal had been suffering from purpura for several days before this investigation started, and was slaughtered by the railway authorities for humane reasons before a clinical examination could be arranged. The following post-mortem examination was commenced four hours after death.

Skin.—It was seen from a superficial inspection of the carcase that there was the usual type of swelling over the pectoral and axillary regions. There was also a prolapse of the rectum; it was confirmed later that this had been present for a considerable period before death. On the removal of the skin it was evident that, whilst subcutaneous œdema was as generalised as usual, subcutaneous hæmorrhage was scarce.

Skeletal Musculature.—No lesions of the type described under horses B, C and D could be found in any part of the musculature.

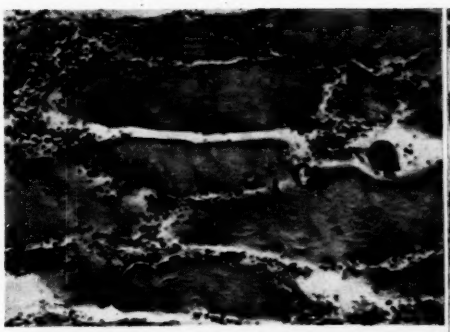
Peritoneal Cavity.—The peritoneal cavity contained a considerable volume of cloudy, yellow fluid. No estimate could be made of the quantity as a considerable proportion was lost before a receptacle was ready.

Omentum.—The surfaces of the omentum were a uniform deep-red colour. Its blood vessels were extremely congested.

Gastro-intestinal Tract.—The gastro-intestinal tract presented changes of spectacular appearance. Numerous petechiæ and ecchymoses were distributed over the serous surface throughout the length of the tract. Great numbers of the petechiæ were minutely small. Some of the ecchymoses, however, were extremely large; e.g., in the terminal portion of the ileum they were approximately 15 cm. long and 2.5 cm. broad. The colour varied from red to black. The general appearance was very suggestive of hæmomelasma ilei. Another conspicuous but probably unimportant feature was that the first and fourth parts of the large colon, i.e., the parts on the right, were much more affected than the second and third parts. The mucous membrane was apparently normal.

In addition to the ecchymoses just described, the duodenum displayed another striking irregularity. Its wall was grossly thickened, so that the tube was nearly twice its normal diameter. Further, the effect of this thickening was to give, upon touching the wall, a most singular sensation of turgidity.

Histological material was prepared from the ileum with the intention, amongst other things, of determining more precisely the nature of the ecchymoses and petechiæ. Unfortunately, however, it became uncertain whether or not

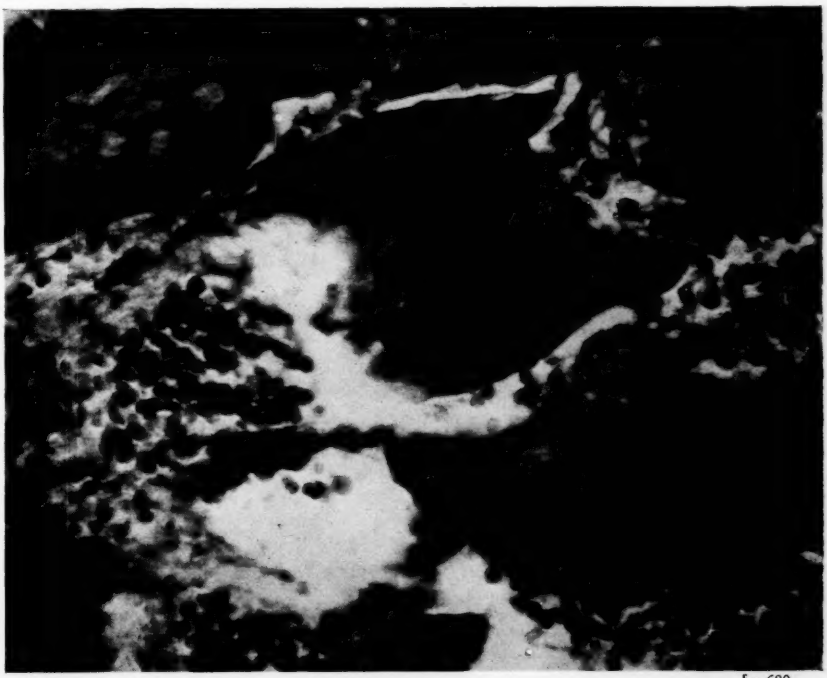


[x 200.

FIG. A.—Stage 2, early.
Swelling of fibres with tendency towards fragmentation. Profuse hæmorrhage (erythrocytes show as black dots). Masson variation.

[x 200.

FIG. B.—Stage 2, late.
Several fibres show extensive degeneration of cytoplasm. Numerous erythrocytes between fibres and in the cytoplasmic debris. Many erythrocytes losing definition owing to hæmolysis. Hæmatoxylin and eosin.



[x 680.

FIG. C.—Stage 2.
Field from bottom-left corner of Fig. B. Shows disintegration of cytoplasm and presence of erythrocytes between fibres and in cytoplasmic debris. Hæmatoxylin and eosin.

(Article by A. S. King)

PLATE IV.

FIG. L.
Psoas muscle from horse B, heavily affected with the lesions described. The normal areas are pale.

NOTE.—Stage 1 has not been photographed since the characteristic changes depend largely on variations in staining-colour reactions.

(Article by A. S. King)

any ecchymoses had actually been cut through. In the sections that were subsequently examined, the subserous connective tissue showed only œdema and there was nothing indicative of hæmorrhage, either recent or organised. There was also œdema of the submucous connective tissue. The only other feature worthy of comment was a massive infiltration of lymphocytes into the lamina propria.

Liver.—The liver appeared macroscopically normal.

Spleen.—The surfaces of the spleen were flecked with ecchymoses and petechiæ.

On histological examination there was no obvious sign of hæmorrhage in or under the capsule, but the capsule appeared to be œdematous. The pulp of the spleen contained granules similar to those which were seen in horses B, C and D.

Kidneys.—There was no apparent macroscopic abnormality in either kidney.

The histological sections prepared were unfortunately all from the cortex only. These sections proved difficult to interpret, but it was evident that a certain degree of abnormality was existent even though a proportion of the changes might have been due to post-mortem factors. Thus there was loss of definition of the cell boundaries of the tubular epithelium, and, in some regions, a tendency towards disintegration of the cells; also there was much non-cellular, poorly-staining, intratubular debris in all types of tubule. A few isolated glomeruli showed indications of degeneration. There seemed to be a moderate and generalised hyperæmia. One or two possible areas of hæmorrhage were present. Inflammatory cells were scarce, and sections stained with van Gieson's stain showed that the quantity and distribution of collagen was not abnormal. Sections stained by the Prussian blue reaction gave a positive response in a patchy distribution; the blue particles were intracellular in the tubular epithelium.

Urinary Bladder.—No abnormality in structure was found. The small quantity of urine present appeared concentrated but not otherwise abnormal.

Lungs.—The apex of both lungs showed great numbers of small abscesses.

Histological examination of one small piece of lung revealed the presence of abscesses, and large areas in which blood, or sometimes possibly œdema-fluid, filled the alveoli.

Heart.—A small number of petechiæ were discovered on the epicardium. Apart from this, the heart was apparently normal.

Horse G.

Horse G was a gelding, and was six years old. It died early on the morning of February 19, 1947, after purpura had lasted eight days. The following post-mortem examination was commenced approximately twelve hours after death.

Skin.—The distribution of swellings was widespread. There was a particularly massive one over the ventral aspect of the abdomen. The subcutaneous tissues showed marked œdema and a few widely separated hæmorrhages.

Skeletal Musculature.—Reddish-black lesions were found in the skeletal muscles, exactly resembling those described under horse B. But in this horse

there were considerable areas of muscle which were quite unaffected. It was noticed that the intermuscular septa and fascial planes were all very œdematous.

Histological examination of these lesions showed that, as in horse B, degeneration of the muscle fibres had occurred, the commonest stage being one of swelling and rupture with extensive hæmorrhages. (For further details see discussion under the heading *Lesions in the Skeletal Musculature.*)

Peritoneal Cavity.—As in horses D and E, the peritoneal cavity contained a large quantity of non-sanguineous yellow fluid.

Omentum.—The omentum was apparently normal.

Gastro-intestinal Tract.—The serous coat of the gastro-intestinal tract was diffusely red in numerous, but small, areas. The mucous membrane appeared, macroscopically, to be normal. The stomach wall was thickened and turgid but not to the same degree as the duodenal wall in horse E.

Section material was prepared from the duodenum. The epithelium was degenerate in all sections, but this was almost undoubtedly due to the prolonged period between death and fixation (over 15 hours). The submucous connective tissue layer was very wide. This was thought to be due to the presence of œdema-fluid; sections stained with van Gieson's stain confirmed this view. The subserous connective tissue layer was slightly thickened by œdema; nothing was evident which could account for the red discoloration seen macroscopically before fixation.

Liver, Spleen and Urinary Bladder.—All these organs appeared macroscopically normal. The urinary bladder was empty.

Kidneys.—Macroscopically, there was no indication of any pathological changes.

The histological sections, which once again unfortunately showed the cortex only, proved as difficult to interpret as those obtained from horse E. On the whole these sections showed a considerable resemblance to those from horse E. Thus there was the same loss of cell definition, though to a more marked degree, with quantities of intratubular debris. There was also a moderate hyperæmia in all parts of the sections. However, most of the cellular disorganisation must in this case be ascribed to post-mortem changes, as there was an excessive delay in fixation (about 15 hours); the observations made on sections of the duodenum (see above), and of the adrenal glands (see below) confirm the impression that post-mortem changes had been active. Nevertheless, there was one other abnormality, which was not seen in horse E and which was unlikely to be due to post-mortem factors. This took the form of numerous, ubiquitous, small, yellow-brown globules within the cells of the tubular epithelium. When tested by the Prussian blue reaction these globules remained unreactive.

Adrenal Glands.—There was no macroscopic abnormality.

Histological examination showed cloudy swelling and some further degeneration, generally near the surface of the organ, which was ascribed to post-mortem changes.

Lungs.—The surfaces of both lungs were mottled with hæmorrhagic areas; the left lung was more affected than the right so that its whole surface appeared

diffusely hæmorrhagic. On cutting into the substance of the organ it was seen that, although in some parts the tissues seemed to be normal, considerable areas were highly congested. In the right lung there were several cavities, of which the largest was about 7 cms. in diameter, containing sanguineous pus. There were also numerous tiny abscesses. The bronchi contained food material and, in places, pus. There was a strong and unpleasant odour.

Some of the sections prepared showed an acute pneumonia, with a fibrinous exudate in the alveoli containing a moderate number of polymorphs and mononuclear cells. Other sections showed more chronic changes with abscesses surrounded by dense layers of fibrosis. Some of the bronchioles were blocked with inflammatory cells.

The following bacteriological examination was made.* Smears of the pus and lung tissues showed gram-positive cocci and gram-negative short rods in very large numbers. However, neither aerobic nor anaerobic cultures yielded any growth other than of hæmolytic streptococci. The suspicion that some of the organisms found in the original smears were Pasteurella could not, therefore, be confirmed. The hæmolytic streptococci belonged to Lancefield's group C and were of the "animal pyogenes" type.

The conclusion arrived at is that these lungs were affected by old-standing lesions of a chronic pneumonia, possibly a concomitant of the original influenza, upon which a more acute pneumonia had been superimposed during the course of the purpura.

Heart.—The fat in the auriculo-ventricular groove showed œdema and petechiæ. The auricular epicardium showed hæmorrhagic areas. The endocardium was devoid of definite hæmorrhages, but was red in patches. The chambers of the heart, particularly on the right side, were extremely dilated.

Histological examination of sections revealed a tendency towards the loss of fibre structure, especially of the transverse striations; this was largely attributed to post-mortem changes. There were, however, several distinct areas of hæmorrhage.

Discussion

The principal objectives in this discussion are first, to attempt to estimate the degree to which the cases reported on were typical of equine purpura, and secondly, to consider certain aspects of the pathogenesis in the light of the morbid anatomical and histological findings reported.

In order to attain the first of these objectives the findings reported above will be compared with the morbid anatomical and histological findings described in two standard textbooks. Such a comparison shows that various features are held in common by the lesions described above and by those regarded by these standard authorities as characteristic of equine purpura. Thus there was a generalised œdema of the subcutaneous tissues and intermuscular fascia in all our cases, and fluid in the peritoneal cavity in all cases except that of horse C. Also, horses E and G showed petechiæ on the heart, and horses D and E

* We are indebted to Mr. E. Cotchin, of the Department of Pathology, Royal Veterinary College, for undertaking this bacteriological examination.

showed petechiæ on the spleen. All these are findings mentioned by both Hutyra *et al.* (1938) and Udall (1943). Also, Udall (1943) mentions a thickening of the intestinal wall similar to that seen in horse E. Furthermore, these authors speak of abnormalities in the lungs, such as hæmorrhage and foci of necrosis, which are presumably comparable with those observed in all our cases except that of horse B.

In some respects, the cases reported above differ from the standard descriptions. Hæmorrhages of the visible mucous membranes, which seem commonly to be considered as pathognomonic of the disease, were not seen in any of our cases except on the nasal mucosa of horse C; nor were any petechiæ seen on any of the internal mucous membranes. However, this point has already been discussed in the previous paper in this series (Symptomatology, Bennett and King [1948]). Also, ulceration of the mucous membranes of the intestinal tract, which is mentioned by both Hutyra *et al.* (1938) and Udall (1943), was never discovered in any of our cases. Similarly, they apparently find that hæmorrhages beneath the capsule of the liver and kidney are common, but in no case did we encounter lesions of this sort.

The conclusion reached in this matter is that, in the cases dealt with in this investigation, the morbid anatomical and histological changes tend to be rather less typical of equine purpura than were the symptoms, but that there is sufficient conformity to the standard accounts to warrant confirmation of the clinical diagnosis.

Having disposed of the first objective of this paper, it is now necessary to discuss some of the morbid anatomical and histological changes in more detail, namely the œdema, the changes in the kidneys, the lesions in the skeletal musculature and the lung lesions, and to conclude by considering the pathogenesis and ætiology in the light of these findings.

The Œdema

According to the standard textbooks already referred to, œdema and hæmorrhages of the subcutaneous fascia share the distinction of being included among the most characteristic features of equine purpura. There is a tendency even to regard the hæmorrhages as the more significant, or fundamental, change. Thus Hutyra *et al.* (1938) introduce their account of the anatomical changes with the words: "The characteristic post-mortem findings are hæmorrhages in the skin and mucous membranes and sero-sanguineous effusions in the subcutaneous and submucous tissues, with inflammation and necrosis as secondary processes." Similarly, Udall (1943) says: "In the subcutaneous swellings one finds icterus and a hæmorrhagic œdema extending into the intermuscular tissue."

Our observations, however, do not support this interpretation of the relationship of the œdema and the hæmorrhage, but indicate that the emphasis should be adjusted in favour of the œdema. Thus, we found that hæmorrhages of the subcutaneous and deeper fasciæ were very variable in the frequency with which they occurred and that in some cases they were decidedly scarce or even virtually absent. Œdema, however, could be found in connective tissue practically wherever it was sought. The most striking example of this point

occurred in horse C. In this case no definite subcutaneous or fascial hæmorrhages were found anywhere, but yet the subcutaneous connective tissue was so œdematous that a clear yellow fluid ran freely from the cut surfaces. Similarly, in horse E, the subcutaneous tissue was equally œdematous and only a very few subcutaneous hæmorrhages were seen. Again, in horse G, the same thing was noticed, and, in addition, it was found that the whole system of intermuscular septa and fascial planes was affected with œdema whilst hæmorrhages were exceedingly rare.

It would seem possible that the frequent association in the literature of œdema with hæmorrhage, in such phrases as those already quoted, i.e. "serosanguineous effusions" or "hæmorrhagic œdema," as though they tended to occur equally and simultaneously, might have arisen from a too superficial examination of cases in which hæmorrhagic areas were present in the subcutaneous connective tissues. Such areas, when they are present, are striking and naturally catch the eye. It can be visualised, however, that the laking of a small quantity of blood could impart to a relatively large area of œdema a sanguineous tinge which would remain quite bright until extensive diffusion ultimately dispersed it. Biochemical examination of the œdema fluid of horse C (see Harvey and Marchant [1949]) was compatible with the view that hæmorrhage was of minor importance in comparison with the œdema; these workers found that the œdema fluid of horse C gave only an extremely weak reaction to the benzidine test, and they concluded that the quantity of hæmoglobin present was very small.

It is of interest also to establish as far as possible the exact nature of the fluid which is usually found in the peritoneal cavity. Hutyra *et al.* (1938) say: "The body cavities contain a varying amount of bloody fluid." Udall (1943) says: "Reddish serum or unclotted blood may be found in the large body cavities." In horses D, E and G (see above) care was taken to ensure that any fluid contained within the peritoneal cavity was not contaminated by blood from the skinned surface of the animal or from the making of a large incision in the body wall. The result was that in all three cases the fluid within the peritoneal cavity was found to be yellow and not visibly sanguineous at all. Biochemical examination was again made (and reported on) by Harvey and Marchant (1949) of a sample of peritoneal fluid obtained from horse D. During collection this sample was slightly contaminated by blood from the dissection. Nevertheless, it gave only a moderate benzidine reaction and apparently contained less than 0.1 gm. per 100 ml. of hæmoglobin.

To summarise what has been said above on this question of the interrelationship of the œdema and hæmorrhage, we have been lead to this conclusion: namely, that the œdema is of primary and fundamental importance, whilst hæmorrhage, even though undoubtedly it may occur, should be regarded as being of only minor significance.

It is thought that this interpretation of the relative significance of the œdema and the hæmorrhage may be important to a better understanding of the pathogenesis of equine purpura hæmorrhagica. It is true that the presence of widespread œdema could be due to a variety of causes, but one *possible* cause

is damage to capillary endothelium resulting in an abnormally increased permeability to plasma colloids. Biochemical examinations of the œdema fluid and of the blood plasma provide one method of testing this hypothesis. Examinations of this sort were made on horse C, and the results are published and discussed in a later paper in this series (Harvey and Marchant [1949]). These results argue in favour of this hypothesis, firstly because the protein content of the œdema-fluid was high as compared, for example, with œdema-fluid of nephrotic or nutritional origin (taken from man), and secondly, because the plasma albumen was reduced to, and maintained at, a subnormal level. Hæmatological examinations provide another means of checking this suggestion. Thus it is to be expected that there should be a tendency towards phases of hæmoconcentration during the time that the plasma constituents are being lost into the tissues; the work of Biggers *et al.* (1949a) during this investigation provides some evidence that hæmoconcentration may, in fact, occur.

Taking all this evidence into account, we have come to the conclusion that damage to the capillary endothelium resulting in abnormal permeability to plasma colloids is likely to be one important factor in the pathogenesis of equine purpura.

The Possibility of Renal Failure

From the point of view of the morbid anatomy and histology, the evidence relating to the possibility of the occurrence of renal failure in equine purpura is contradictory and difficult to evaluate. Macroscopically no abnormality was detected in the kidneys in any of the five cases examined. Nevertheless, histological changes were observed in the kidneys of horses D, E and G. It is true that, in the latter two cases, post-mortem degeneration could have been partly or largely responsible. In the case of horse D, however, marked structural changes had taken place which, it is thought, could not have been due to post-mortem factors alone. Unfortunately, the histological findings in horses E and G are unreliable owing to the delay in fixation; also we do not know of any published work which mentions histological examination of the kidneys in equine purpura. Consequently, the histological findings in horse D remain unconfirmed. It is clear that estimation of the functional significance of these renal lesions is very difficult.

Biochemical methods must be given due consideration in any investigation of renal failure. The evidence from this source, however, is equally conflicting. The statement has been made by various authorities, ranging from Field (1843) to Hutyra *et al.* (1938) and Udall (1943) that blood appears in the urine of severe cases; the two latter authorities also say albumen is present in such cases. These observations appear to suggest kidney damage, but, unfortunately, it is doubtful whether they can be relied upon with certainty, since these authorities do not indicate whether or not their observations are based on the requisite biochemical analyses. In our investigation, Harvey and Marchant (1949) undertook biochemical examinations of blood and urine samples from a severe case (horse C) and a mild case (horse F). (Unfortunately, horse D was dead before any clinical examination could be made.) They found that all the more com-

mon pathological constituents of urine were absent in every instance and that there was no abnormality of the blood which might suggest renal failure. Only one specimen showed any abnormality; this was a urine sample from horse D, which gave a positive benzidine reaction. However, this sample was taken from the bladder some hours after death and, furthermore, the reaction was not a very strong one. Harvey and Marchant come to the general conclusion that, in the cases they examined, kidney function was normal.

It would appear therefore that, owing to this conflict of evidence, it is not yet possible to find a definite answer to this important question of the occurrence of renal failure in equine purpura. The importance of this matter lies in the fact that the clinical course of the disease could be profoundly influenced by the onset of renal failure. However, it does seem to be established that renal failure is not an invariable complication.

We would like to submit two other impressions which have been gained during our consideration of this problem. First, we believe that, apart from a few comparatively minor differences, the histological changes in the kidney of horse D resemble the renal lesions in the crush syndrome in man, as described by Bywaters and Dible (1942). Various features are held in common: e.g. the glomeruli are normal or near-normal, there is degeneration and desquamation of the tubular epithelium and there is hyaline-like material in and between the tubules. Secondly, we wish to comment on the observation, made on the histological sections of the kidney of horse D, that a marked hyperæmia involved the medulla but not the cortex. Here again there may be a relationship to the crush syndrome, because this type of abnormality has often been hinted at in accounts of that condition, e.g. see the case of Beall *et al.* (1941) and case No. 1 of Bywaters and Beall (1941). Furthermore, Trueta *et al.* (1947) have produced the same phenomenon experimentally by trauma and also, it may be of interest to note, by the intravascular introduction of certain toxic factors; they have suggested that the explanation is to be found in neurovascular reflexes controlling the arterial by-pass through the vasa recta.

These points of resemblance to the crush syndrome, although of uncertain nature, were of interest to us for the following reasons: First, there is reason to believe that in both the crush syndrome (Moon, 1944) and equine purpura (see below) damage to the capillary endothelium is an important factor in the pathogenesis; if this hypothesis is correct it might be expected that similar renal lesions would occur in both conditions. Secondly, in the crush syndrome renal failure is a common and often fatal complication (Bywater, 1942); demonstration of similarity between the renal lesions in the crush syndrome and in equine purpura would strengthen the suspicion that renal failure might play an important part in the latter condition also.

Lesions in the Skeletal Musculature

Hutyra *et al.* (1938) and Udall (1943) appear to differ somewhat in their accounts of the nature of the lesions in the skeletal musculature in equine purpura. Udall (1943) says that the muscles may show hæmorrhage, necrosis or abscess formation. Hutyra *et al.* (1938) are more specific and describe a

pale greyish-brown appearance of the muscle due, so it is said, to parenchymatous or fatty degeneration, with scattered hæmorrhages and, in some places, small necrotic areas brownish-red in colour. They seem to imply that the pale greyish-brown regions are common and widespread. Udall (1943) does not appear to be familiar with this parenchymatous or fatty degeneration, and certainly in our cases we did not observe degeneration of this sort. However, if it is agreed that degeneration of the skeletal musculature is common and widespread in equine purpura—and there appears to be a good deal of evidence that this is the case—then, in our opinion the description as given by Hutyra *et al.* (1938) should be accepted, because it seems to agree with the usual appearance of striated muscle in degeneration. Thus it tallies with the colour and appearance of the lesions in equine azoturia (Udall, 1943), in stiff lamb disease (Udall, 1943, and Cotchin, 1948), in trauma by crushing (Bywaters, 1942), and in certain post-pneumonic cases in man (Forbus, 1926). Where this type of degeneration is omitted from descriptions of equine purpura, as in our account, we feel that it may have been overlooked during the post-mortem examination.

Although realising that probably we were dealing in our investigation with only one of the possible varieties of muscle-lesion which may occur in equine purpura, we attempted to establish fairly fully the morbid anatomy and histology of the conspicuous reddish-black hæmorrhagic lesions alluded to by Udall (1943) and Hutyra *et al.* (1938), and described in this paper (see above).

Macroscopically it was found that the number of these lesions varied considerably in the different cases. In one case, horse B, they were so numerous that they imparted to the musculature a truly astonishing appearance. In horse E, however, they were apparently absent altogether, and in horse C there were only a very few indeed. In horses D and G they could be found, but only by careful searching, and we tentatively regard this as being the average finding. The general conclusion, based on these few cases, is therefore that usually these lesions are present but not numerous, although extreme variations in numbers may occur.

Histological sections were prepared from horses B, G and H. The results were not uniformly good, but after using a number of different fixatives, of which Zenker-formol and formol-saline were found to be the best (see above under **Methods**), satisfactory sections were obtained. In sections of a number of different lesions the following four stages of degeneration could be distinguished; they are arranged in the order in which they are thought to occur.

Stage 1.—The early phases in the development of these lesions are the most difficult to identify since the changes are not as yet very well marked. It seems, however, that there is a tendency for some individual fibres, especially those bordering on highly abnormal areas, to lose their transverse striations and to show various alterations in their staining reaction, including, for example, the appearance of a hyaline-like coloration. The nuclei remain normal. Occasionally such fibres appear swollen and broken into pieces.

Stage 2.—Swelling and fragmentation of muscle fibres, with massive hæmorrhage: The muscle fibres are swollen and broken into fragments through-

out their length, often over large areas. The cytoplasm within the sarcolemma is generally in the process of dissolution; sometimes it appears as poorly-staining, irregular, disintegrating, granular material which has shrunken away from the sarcolemma; less commonly the cytoplasm breaks up into small isolated lumps, which are homogeneous and eosinophilic. Sometimes, following the destruction of the cytoplasm, the sarcolemma appears to persist. The fate of the nuclei is hard to determine, but it seems certain, however, that at least a considerable proportion must be lost. Hæmorrhage is copious and widespread; it not only penetrates between the fibres, but even invades the stumps of ruptured fibres and occupies the space within the sarcolemma left by the disintegration of the rest of the cytoplasm. Sometimes the hæmorrhage spreads from the site of the lesion and splits apart groups of normal fibres, and at other times it spreads along the perimysium. Inflammatory cells are present in varying numbers, but usually they are not very numerous; neutrophil leucocytes predominate and sometimes eosinophils are numerous.

Stage 3.—Removal of debris: Great numbers of large, mononuclear, phagocytic cells invade the cytoplasmic debris, which at this stage is usually visible only as small amounts of scattered, granular material lightly stained with eosin. Sometimes strips of sarcolemma still seem to be visible. Erythrocytes are now scarce, but isolated individuals can be picked out in almost any field; a fair number can generally be found engulfed by the large mononuclear cells.

Stage 4.—Beginning of repair: A new type of cell is now conspicuous and is present in large numbers approximately equalling the large mononuclear cells. These new cells usually appear spindle-shaped with pointed ends, but sometimes are seen to possess several processes; the nucleus is elongated, oval and lightly stained, and tends to be large. It is difficult to say whether these are the regenerating muscle cells described by Forbus (1926) and others or whether they are fibroblasts. In our sections we have never seen the longitudinal striations and multinuclear structure which characterise regenerating muscle cells; on the other hand, van Gieson's stain showed that these cells are not, in any of our sections, associated with the appearance of collagen. On the whole, we incline to the view that these cells are fibroblasts. Presumably, therefore, repair is effected chiefly by scar tissue. It can be said with certainty that regeneration by heavily nucleated, plasmodial outgrowths from non-degenerate muscle fibres, as described by Le Gros Clark (1946), cannot anywhere be discerned.

The commonest stage encountered was Stage 2, with swelling, fragmentation and massive hæmorrhage: there seems little doubt that this hæmorrhage accounts for the reddish-black colour of the lesions when seen macroscopically. At all stages there were signs of œdema. The perimysial and epimysial connective tissue does not degenerate.

The above account of the histopathology can only be regarded as a preliminary one and needs to be confirmed by examination of material from many more cases. The veterinary literature, unfortunately, does not provide much help in checking these findings, since very little work seems to have been published on this subject. The only reference we have found occurs under a

WELLCOME INSTITUTE LIBRARY

general description of hæmorrhage into muscle (Nieberle and Cohrs, 1945); it mentions that in equine purpura hæmorrhagica there are hæmorrhages, hyaline or fatty changes, or necrosis of the muscle fibres, and inflammatory reactions round these regions. This account is very brief, but it does not appear to differ greatly from our findings.

We have compared these muscle-lesions in our cases of equine purpura hæmorrhagica with the muscle-lesions in a variety of other conditions. It is a matter of interest that there is some resemblance to the muscle-lesions which sometimes develop in fatal cases of primary and, more commonly, secondary pneumonia in man (Forbus, 1926). In the great majority of Forbus's cases the fatal pneumonia was secondary to an initial influenza. This would seem to be of direct interest, since, in equine purpura, influenza is often a precursor, and pneumonia is often a fatal termination. However, the matter does not end here. Forbus regarded his post-pneumonic muscle-lesions as being identical, histopathologically, with those described by Zenker and others in typhoid fever: a number of observers, listed by Fishback and Fishback (1932), have suggested that Zenker's degeneration is not confined to typhoid but occurs in numerous other conditions, including tetanus, cholera, scarlet fever, influenza and pneumonia, and also in anaphylaxis. The connection between equine purpura and these other conditions through the similarity of their muscle lesions may in every case be purely coincidental; on the other hand, it may possibly open up a useful avenue of approach to the problem of the ætiology and pathogenesis of equine purpura hæmorrhagica.

The Lung Lesions

The frequency with which suppurative lesions were found in the lungs in our cases (see above) seems to us to be worthy of comment. Horse B was the only case which was entirely devoid of these lesions. All the others, C, D, E and G, showed macroscopically fairly numerous small abscesses; also D had larger abscesses and a purulent bronchopneumonia, and G showed a generalised acute pneumonia and large cavities of pus.

The second point of importance is the presence in the alveoli of what was believed to be œdema-fluid. This œdema-fluid was observed definitely in horses C and D, and probably in E. As stated above, we believe that an important factor in the pathogenesis of equine purpura is damage to capillary endothelium with a resultant abnormal permeability. Under such conditions one would expect the accumulation of œdema-fluid in the lung alveoli; this expectation is confirmed by the experimental work of Moon and Morgan (1936). Theoretically, pulmonary œdema of this sort is likely to be a factor predisposing to pneumonia, and this view is supported by the clinical observations of Moon (1938). Consequently it is interesting to note that pneumonia is regarded as being one of the more common complications of equine purpura hæmorrhagica (Hutyra *et al.*, 1938).

Consideration of Pathogenesis and Ætiology

Having now completed the discussion of the more important morbid anatomical and histological findings reported in this paper, it is of interest to

see whether these findings can offer any assistance in the elucidation of the problems of pathogenesis and ætiology.

Pathogenesis.—In our opinion the most important point which has arisen from the findings reported in this paper is the conclusion that damage to the capillary endothelium with resultant abnormal permeability to plasma colloids is likely to be an important factor in the pathogenesis of equine purpura.

Assuming the validity of this initial conclusion, the question which now arises is, *to what degree* does this factor of endothelial damage control the pathogenesis? In order to answer this question one must consider two points: (1) How widely throughout the body capillary damage has occurred; and (2) how severely the endothelium has been damaged?

(1) Œdema was seen macroscopically in our cases in the following sites: the subcutaneous fascia in all the cases; the peritoneal cavity of horses D, E and G; the pericardial fat, intermuscular fascial planes and stomach wall in horse G; the duodenal wall in horse E. Microscopically, signs of œdema were observed in: the skeletal musculature of horses B, G and H; the lungs of horses C, D and E; the subserous coats of the small intestine in E and G; the capsule of the spleen of E. Both Udall (1943) and Hutyra *et al.* (1938) mention œdema of the wall of the alimentary canal and respiratory passages. In view of all the above evidence, we believe it is reasonable to assume that in equine purpura the œdema, typically, is generalised throughout the body.

(2) Estimation of the severity of the damage to the capillary endothelium seems to us to be properly a biochemical problem. Unfortunately, very little information on this point is available. Harvey and Marchant (1949) did examine a sample of the œdema-fluid from horse C. Their results show that the smaller molecules, *e.g.* albumin, had passed the endothelium quite freely, but that the larger molecules, *e.g.* globulin, had only passed in very small amounts. These results confirm the principle that damage has occurred, but do not enable one to draw any general conclusions about the severity of the damage. In the particular case examined, i.e. of horse C, it would appear, however, that the damage to the endothelium was moderate and certainly not drastic.

In view of our inability at the present time to answer point 2 satisfactorily, it seems that one cannot with certainty decide to what degree the factor of endothelial damage controls the pathogenesis. However, in view of the evidence that this damage is so widespread throughout the body we have come to this general conclusion, namely, that damage to the capillary endothelium is probably a very important factor in the pathogenesis, but that its full significance is not yet definitely established.

In an attempt to obtain more information about this matter we have considered the possibility that the pathogenesis of equine purpura might be very similar to the pathogenesis which Moon (1944) believes to operate in a large group of seemingly widely different conditions, including extensive trauma, abdominal emergencies such as intestinal strangulation, and metabolic intoxications. According to this authority, the modus operandi in these conditions begins in every case with severe and widespread damage to the capillary endo-

XUM

thelium by some capillary toxin, with resultant abnormal permeability to plasma colloids. The sequence of events which is thought to develop from this initial damage can be summarised as follows: disturbance of the fluid balance; formation of œdema and effusions into the serous cavities; hæmoconcentration and reduced actual blood volume; attempt at compensatory distribution of blood to the vital organs at the expense of the non-vital parts; tendency towards failure of this compensation, with resultant circulatory embarrassment; further damage to capillary endothelium through anoxia; relaxation of capillary endothelium producing capillo-venous congestion; stasis; dissolution of capillary walls causing petechiæ and ecchymoses; advanced or fatal circulatory embarrassment.

When considered on the basis of the morbid anatomy and histology alone, the suggestion that the pathogenesis of equine purpura might operate in this way is, at first sight, somewhat attractive. Thus Moon's group of conditions includes among its most characteristic features œdema, effusions into the serous cavities, hæmorrhages and capillo-venous congestion (Moon, 1944); there are abundant indications that these are common findings in equine purpura. Nevertheless, for the three following reasons we do not believe that the pathogenesis of *all* cases of equine purpura follows this course. (1) Whilst in general the morbid anatomical and histological changes in purpura resemble the findings which are characteristic of Moon's group, *individual* cases of purpura do not by any means always conform to the requisite pattern. (2) Renal failure is a very common complication in severe cases in Moon's group of conditions (Moon, 1944). There is, as yet, no evidence that this is so in equine purpura (see above under *Possibility of Renal Failure*). (3) Unless there has been considerable hæmorrhage, all severe cases in Moon's group are characterised by fluctuating but definite hæmoconcentration (Moon, 1944); in equine purpura the available evidence indicates that, whilst hæmoconcentration may occur in some cases, *severe anæmia* is a much more common finding (Biggers *et al.*, 1949a). In our view the third of these objections, by itself alone, is sufficient to show that it is not possible that all cases of equine purpura undergo a pathogenesis in the way described above.

Probably equine purpura differs in its pathogenesis in that the capillary endothelium, although very widely affected, is usually not so severely damaged as in Moon's group of conditions. We do feel, however, that the possibility remains that in some cases of equine purpura the pathogenesis may operate by some closely similar mechanism.

Since further consideration of the pathogenesis depends on detailed analysis of the symptomatological, hæmatological and biochemical findings made in this investigation, further discussion of it must be deferred until the final paper of the series (Biggers *et al.*, 1949b).

Ætiology.—The conclusion that damage to the capillary endothelium is an important factor in the pathogenesis of equine purpura hæmorrhagica necessarily introduces another problem, i.e. discovery of the cause of the damage. In our opinion the findings reported in this paper offer no tangible information on this matter, and therefore discussion of it will be delayed until the final paper (Biggers *et al.*, 1949).

Summary

1. The morbid anatomical and histological findings in five severe cases of equine purpura hæmorrhagica are given. Certain findings in a sixth case are also reported.

2. Although in certain important respects, notably in the rarity with which petechial hæmorrhages occurred on the mucous membranes, the findings deviate from those usually described in equine purpura hæmorrhagica, they are regarded as sufficiently typical to warrant confirmation of the clinical diagnosis.

3. Analysis is made of the relationship between the œdema and the hæmorrhage of the subcutaneous tissues. It is concluded that the œdema is of primary and fundamental importance, whilst the hæmorrhage is only of minor significance.

4. The possibility that renal failure may occur in equine purpura hæmorrhagica is examined. After consideration of the evidence from the morbid anatomical and histological, and from biochemical findings, it is found that no definite conclusion can be reached. The renal findings in horse D are compared to the renal findings characteristic of the crush syndrome.

5. The macroscopical appearance and distribution of the lesions in the skeletal musculature are discussed and the possibility that more than one type of lesion may occur is mentioned. The results of a histological examination of the scattered reddish-black lesions seen in all but one case are given. Four stages in the development of these lesions have been distinguished: (1) Changes in staining reaction of the muscle fibres with loss of some structural features; (2) swelling and fragmentation of fibres, over large areas, with massive hæmorrhage; (3) removal of the debris by phagocytic cells; (4) repair, probably chiefly by fibroblasts. Comment is made on a resemblance of these lesions to those which occur in man in certain cases of pneumonia secondary to influenza and in other conditions.

6. The regularity with which suppurative lesions were found in the lungs receives comment. The frequency with which œdema-fluid was found in the alveoli is noted, and the possibility that this œdema might predispose to pneumonia is considered.

7. The conclusion is reached that damage to the capillary endothelium, resulting in abnormal permeability to plasma colloids, is probably a very important factor in the pathogenesis of equine purpura hæmorrhagica.

8. It is found that the findings reported in this paper do not indicate how this capillary damage could be brought about.

Acknowledgments

I am indebted to J. D. Biggers and P. L. Ingram, then in the Department of Physiology of the Royal Veterinary College, for their assistance in all aspects of the work done in preparing this paper; to E. Cotchin, of the Department of Pathology of the Royal Veterinary College, for undertaking the bacteriological examination reported under horse G and for calling attention to certain references; to J. B. Edwards, senior technician in the Division of Biology of the

XUM

Royal Veterinary College, for his invaluable assistance in the preparation of the histological material; and to B. Burgess, senior technician in the Division of Histology of the Royal Veterinary College, for making the microphotographs.

REFERENCES

Bennett, P. M., and King, A. S. (1948): *Vet. J.*, **104**, 414.
Beall, D., Bywaters, E. G. L., Belsey, R. H. R., and Miles, J. A. R. (1941): *Brit. Med. J.*, 432.
Biggers, J. D., Ingram, P. L., and Murray, C. B. (1949a): *Brit. Vet. J.* (in press).
Biggers, J. D., King, A. S., Harvey, D. G., Ingram, P. L., and Marchant, R. H. (1949b): *Brit. Vet. J.* (in press).
Bywaters, E. G. L. (1942): *Brit. Med. J.*, 646.
Bywaters, E. G. L., and Beall, D. (1941): *Brit. Med. J.*, 427.
Bywaters, E. G. L., and Dible, L. H. (1942): *J. Path. Bact.*, **54**, 111.
Carlton, H. M., and Leach, E. H. (1938): *Histological Technique*, 2nd Ed., Oxford Univ. Press.
Cotchin, E. (1948): *Vet. J.*, **104**, 102.
Field, W. (1843): *Posthumous Extracts from the Veterinary Records of the Late John Field*, Longman, Brown, Green and Longman, London.
Fishback, D. K., and Fishback, H. R. (1932): *Amer. J. Path.*, **8**, 193.
Forbus, W. D. (1926): *Arch. Pathol.*, **2**, 318.
Harvey, D. G., and Marchant, R. H. (1949): *Brit. Vet. J.* (in press).
Hutyra, F., Marek, J., and Manninger, R. (1938): *Special Pathology and Therapeutics of the Diseases of Domestic Animals*, Vol. I, 4th Ed., Baillière, Tindall and Cox, London.
Le Gros Clark, W. E. (1946): *J. Anat., Lond.*, **80**, 24.
Moon, V. H. (1944): *Brit. Med. J.*, 773.
Moon, V. H. (1938): *Arch. Pathol.*, **26**, 132.
Moon, V. H., and Morgan, D. R. (1936): *Arch. Pathol.*, **21**, 565.
Nieberle, K., and Cohrs, P. (1945): *Lehrbuch de Speziellen Pathologische Anatomie der Haustiere*, 2nd Ed., Jena, Gustav Fischer.
Trueta, J., Barclay, A. E., Daniel, P. M., Franklin, K. J., and Pritchard, M. M. L. (1947): *Studies of the Renal Circulation*, Blackwell Scientific Publications, Oxford.
Udall, D. H. (1943): *The Practice of Veterinary Medicine*, 4th Ed., Ithaca, New York.

SOME ASPECTS OF ANIMAL HUSBANDRY in Relation to Preventive Medicine

By L. E. HUGHES, M.R.C.V.S., D.V.S.M., N.D.A.

Veterinary Investigation Department, University College of Wales, Aberystwyth

ANIMAL husbandry may be defined as that branch of farming which pertains to the management, feeding and breeding of livestock. The purpose of animal husbandry is to maintain healthy herds and flocks in order to produce human food. The object of preventive medicine is the maintenance of health by the prevention, control and elimination of disease. Thus animal husbandry and veterinary preventive medicine have a common objective in the promotion of health in domesticated animals. Efficient husbandry entails the management, the feeding and the breeding of animals so that maximum productivity and health are attained and maintained in any particular set of conditions or circumstances; it becomes obvious that the tenets of good husbandry vary from region to region and the husbandman must consider the animal in relation to its environment.

Efficient animal husbandry is closely linked with efficient crop husbandry and both are inseparable from the natural environment. The natural environmental conditions determine to a very great extent the type of farming in any area and the most important of these are the local soil, geographical and climatic

conditions. All three of these are closely inter-linked and they indirectly determine the animal husbandry in a particular area; they are the major limiting factors in any system of crop or animal husbandry. It is evident that the better the soil conditions the greater the flexibility of the farming system possible, but ultimately this flexibility is limited by the prevailing climatic conditions, as under any set of conditions it is the weather which finally determines the length of the winter period during which plant life ceases its growth and when certain classes of animals must be fed indoors. The weather ultimately is of the greatest importance in determining what foods are available for farm animals during the winter period. Thus it is easier to make and maintain good pasture swards in a wet climate, but under such conditions haymaking is made more difficult and silage and grass drying become of prime importance as methods of conservation of food materials. It is no accident therefore that although, generally speaking, the better soils and the greater proportion of arable land are found in this country in the East and South, the concentration of grazing animals is greatest in the West and the North.

The environment determines very largely the problems of the husbandman. In the most fertile agricultural areas in this country the land is too valuable for stock carrying in any form other than the feeding and management of fattening bullocks in yards in the winter time and the care of a few work horses, whose numbers are annually becoming smaller. Under such conditions the animal's environment is almost completely under the control of the husbandman and animal health problems are few and relatively simple. These bullocks serve one main purpose, namely, to reduce the cellulose and lignin of straw to the state most suitable for application to the land for the maintenance of its humus content. If a system of composting giving equally good results more cheaply could be devised any financial loss incurred in the feeding and fattening of such animals, now considered a part of the farming economy, would be obviated.

At the other extreme in this country is sheep farming on high mountains in Wales, the north of England and Scotland, where the soil is relatively shallow and poor, the rainfall high, the growing season short and the winter conditions are rigorous and hard. The system of farming in these areas is relatively inflexible, conditioned as it is by factors outside the control of the farmer. At the same time considerable scope exists for initiative in the tending and general management of the flock within the defined environmental limits.

Between these two extremes of husbandry lie all the types of British farming with their differences in cropping and stocking, each subject to the effects of the major limiting factors of soil, geographical and climatic conditions in varying degrees. It is obviously impossible to discuss exhaustively this question, but attention may be drawn to certain aspects of animal husbandry in relation to preventive medicine which are of general interest.

Some of the best examples of sub-clinical disease lie in the realm of helminthology and nutrition. Taylor has shown that animals may suffer from the depredation of parasitic worms although they show no signs of cognate

XUM

disease. The young animals on many farms during an average winter suffer in varying degrees from parasitic infestations, infestations which are closely related to the nutritional status of these animals.

The self-contained unit in which the young stock are reared on the same farm as that on which the milk is produced is generally accepted as the best method of dairy farming. So far as animal health is concerned the self-contained unit is generally regarded as having a better bill of health than those holdings in which continual purchases are made in the open market, whence it is known disease is spread. In addition to the value of the self-contained unit in relation to the prevention of disease and the maintenance of a clean bill of health, it has been possible under this system of husbandry to effect an improvement in breeding, based upon the recording and subsequent grading up of commercial cows. But on these self-contained units a continuous conflict exists for the limited amount of winter food available between the adult producing animals (animals producing milk for sale) and the young growing animals. Consequently both suffer but particularly the young animals whose need for protein and mineral elements is greater. There is no doubt that on many self-contained farms the young stock get less than their share of the winter food material. This may be illustrated by outlining the history of a small farm of about 72 acres in the Mid-Wales province which lies at an elevation of 500-600 ft. in a particularly high rainfall area of over 60 in. per annum. The soil is medium quality light loam with an adequate system of natural drainage. In the past the system of mixed farming followed was typical of the region and consisted of a combination of butter-making and store cattle rearing, the keeping of a small flock of sheep and a fairly large poultry flock together with the fattening of a litter of pigs each year. When the price levels changed in the 'thirties and when milk production assumed great importance during the war, the farmer changed the system to that of dairying and milk selling to the M.M.B. At first he found it difficult to make the new system of dairying pay any better than the old system of mixed farming. Eventually he sought advice and his farming system and enterprise was planned for him in 1944. At that time he had on the holding 29 head of cattle including 12 dairy cows, 3 working horses, 20 breeding ewes, 6 fattening pigs and about 200 poultry. An endeavour was made to specialise in milk production and a series of seven rotational grazing paddocks was arranged together with a five-course rotation in the arable block (corn, roots, corn, hay, hay). In the course of a short time the flock of sheep and two of the working horses were disposed of and the poultry halved, whereas the dairy cows were increased from 12 to 21 and later to 23, the total cattle raised to 42, and the milk sales increased from 5,000 gallons to 12,000 gallons per annum. The minimum number of heifers was reared for replacement purposes, but it was found in the early years of the change that the competition between cows and young cattle for the available winter food practically always weighed against the young animals and they were in relatively poor condition in the winter time, being heavily parasitised both externally and internally. It must be a great temptation for the farmer to divert as much food as he thinks he can afford to

those animals which are at the time making a direct contribution to the income; this generally results in the young animals getting less than their share of the winter food available. To correct this state of affairs a plan has been devised based upon the efficient manuring of young leys for the production of grass ensilage which it is hoped will provide adequate winter food for the mature cows and the young cattle. During the summer of 1948 about 75 tons of grass ensilage were made and at the time of writing, the young cattle as well as the cows are in good condition.

Is it possible to recommend a system of dairy husbandry where the desirable feature of a self-contained unit are retained but in which the conflicting interests of the young and the adult animals are reconciled? Is it possible to maintain the integrity of the self-contained unit and increase the number of milk-producing adults by a transfer of the young calves, as soon as practicable after birth, to other holdings preferably at a higher elevation where the whole farming economy is designed for the rearing, housing and nutrition of young adult bovine animals? Under such a system of calf and young stock rearing on a holding with buildings designed and constructed for the purpose and with the cropping programme planned to the same end, the nutritional status and health of the young animals can be a first consideration. Such a system is essentially similar to Ostertag's method for the control of tuberculosis and lends itself to the promotion and maintenance of preventive disease control measures generally.

While it is appreciated that systematic milk recording is the only sound method of assessing the ability of individual dairy cows to fulfil their function, it is possible that publicity given to abnormally high yields has resulted in an emphasis in the wrong direction. Has too much attention been directed to the yields of individual cows? It is a fairly widely held conception or misconception that a continuous drive for individual high yields leads ultimately to a deterioration in health. If this widely held view is correct it may be more profitable to think and act in terms of yield per acre rather than yield per cow. In any case there is an advantage in thinking in terms of gallons per acre in that the milk production is thus linked up with the general management so that the emphasis is directed towards the farming operations as a whole rather than towards one aspect of them. While still giving direction to breeding methods, there can be no doubt that this line of thought would also lead to improved crop husbandry, particularly in the production of crops grown as animal foods; this emphasis should lead to a wider application of modern technique in grassland management, particularly systems of rotational grazing.

Rotational grazing together with a system of ley farming can contribute a substantial reduction in the length of the indoor winter feeding period. It is outside the scope of this article to discuss ley farming—it will be enough to understand clearly what is meant by the term. Ley farming may be defined as a system of crop husbandry based upon the four-course rotation in which the single year's " seeds " is extended to a period of 3-4 years or more, thus providing for equal periods under tillage and grass. This means that the plough is used

extensively and the short term or ley pastures come up in rotation. There may or may not be direction as to cropping of farms in future, but there is little doubt that a minimum acreage of ploughing will be stipulated. On any particular holding it may be possible to reserve certain parts of the farm for the arable acreage and to utilise the remainder as grassland, part of which comprises the hay fields and the remainder the grazing pastures, but this is not the best system —the plough should travel round the whole farm in rotation. It may be quite impossible to plough certain fields because of their configuration, particularly in hilly districts, and although in certain areas it may be unwise to break the sward, e.g., on floodable land or in the case of very productive fattening pastures, generally speaking, most farms can be brought to and kept at a higher plane of production with benefit to all fields, including the pastures, if the rotation followed includes, so far as possible, the total acreage. Under a system of ley farming, where the plough plays such an important part, the planning of the cropping programme becomes of vital importance, particularly so far as the stock is concerned in relation to winter and spring nutrition. Under such a system cruciferous crops such as rape and kale for winter feeding and rye and Italian ryegrass, which start growth relatively early in the spring, can be utilised in an effort to lengthen the growing season. There is little doubt that the pedigree strains of grasses and clover bred by the Welsh Plant Breeding Station have made some contribution towards this desirable end. The work of the P.B.S. is sometimes criticised with the contention that what the station has done has been to exaggerate the unbalance already present between the available summer and winter food supplies. This is not a valid criticism—what has taken place is a failure to conserve and a failure to develop methods of conservation of the increased summer and autumn production.

A system of rotational grazing involves the use of relatively small fields, all supplied with water, upon each of which sufficient grazing is available for a relatively short period. In this country, where such a system is employed, cows in production are given the first "bite" and "followers," comprising dry cows and young stock, eat off what remains. At first sight this may appear a dangerous practice in that the young stock in following the older animals are exposed to helminth infection.

However, in the somewhat limited experience of the writer, so long as the young stock are kept under constant supervision no ill-effects need result from this method of stocking the pastures. It is possible that the reason why helminthiasis does not become a major problem is that the adult animals remain on the rotational grazing plots for a period of three to four days only and the young animals for a similar period during which, under pasture conditions, relatively few nematode larvæ reach the infective stage. When the plot is grazed the second time round in rotation the cows are the first to reach the plots. They add relatively few eggs and ingest large numbers of infective larvæ from the pastures, relatively few of which survive to reach the egg-laying stage in the intestines of the cows, which have a well-developed immunity. If the order or grazing is reversed the young cattle have the first "bite" and are followed

by the older animals. In these circumstances the older animals do not greatly reduce the numbers of infective larvæ and the young animals are exposed to a heavy pasture infestation on the second and subsequent rounds of the rotational grazing. On the other hand, the results obtained by McMeekan,[1] when calves were allowed the first " bite " in the rotational grazing paddocks, are better than any obtained in this country. He obtained a live weight in excess of what is regarded as normal in this country and well in excess of that of control calves grazing other pastures not on a rotational system. His results were obtained with calves; it is not the practice on many farms in this country to allow spring-born calves out to pasture during their first year. It is undoubtedly a sound practice to house these young animals during their first summer so long as the housing accommodation is adequate and the diet contains sufficient fresh green fodder. This means that the young followers are comparable to McMeekan's calves. Although, as already stated, there is no evidence that this order of grazing would reduce the dangers of helminth infestation to these young animals, it is possible that better results would accrue from it, rather than from the conventional order of rotational grazing, by virtue of the fact that the young animals would have the first " bite " so allowing play for selection in their grazing habits. A system of rotational grazing is not bound up with permanent pasture as the paddocks can be ploughed up in rotation, although there is little doubt that such a system is easier to follow under permanent pasture conditions. Discrimination, however, must be shown in the use of the mowing machine in an endeavour to prevent the majority of the grasses from reaching the flowering stage, which would reduce the quality of the pasture. A premier rule of good pasture husbandry is to encourage vegetative growth by resting at appropriate periods, followed by hard grazing when sufficient growth is obtained before the grass becomes too stemmy and the flowering heads appear. This means that the mowing machine must be used on certain of the rotational paddocks in June and July.

The relationship of diseases other than helminthiasis to a rotational grazing system is of considerable importance; a system of pasture management is important in relation to the spread of Johne's disease and of Salmonellosis in adult cattle, in those areas where the disease is known to exist. The contamination of pasture by carriers of these diseases is of prime importance and the danger of the spread of such enteric diseases is increased where intensive and close grazing techniques are followed. On the other hand, a piped water supply is an essential part of a well-managed rotational grazing system, ensuring a supply of fresh water free from pathogenic bacteria, so reducing the danger of infection arising from contaminated pools.

Sheep

Changes have taken place in mountainous areas during the last fifty to sixty years which constitute a minor social revolution. A movement of population has taken place from the hill areas so that communities of hundreds have become twos and threes. This movement although not entirely related to economic changes is closely bound up with them. The advent of refrigeration and rapid

transport facilities has contributed to this movement which has resulted in the disappearance of a sturdy hill type of family, and with them their hill grazing cattle. It should be noted here that cattle grazing hill pastures are said to reduce the bracken which has overrun the lower slopes, and, by grazing the coarser grasses, to improve the sward for sheep. In the years before the last war imported mutton and changes in public taste had resulted in changes in husbandry in hill flocks with a resultant virtual disappearance of adult hill wethers. This disappearance of resident hill families, including shepherds, of wethers and hill cattle has resulted in the system of hill farming becoming more like-range in its management with a consequent increase in importance of problems of health in the hill flocks.

These numerous factors have led in varying degrees to a serious deterioration in hill pastures and public funds are now expended in the form of subsidies to induce farmers to graze their cattle on the hills in the summer time. Experience gained during the last few years has shown that it is necessary to utilise adult cattle for grazing on high ground and that some breeds do better than others, e.g., Hereford and Welsh Blacks. The utilisation of hill pastures for the summer grazing of cattle is limited in some areas by the presence of ticks acting as vectors of Babesiosis. Relatively little work has been done on this disease in recent years, but if these hill pastures are to be properly utilised the subject may have to be reopened in order to find out whether it is possible to develop an immunological method which will protect susceptible stocks grazed on the hills in the summer time.

In recent years considerable attempts have been made to increase the productivity of hill pastures, which normally carry an abundance of summer herbage and nothing in the winter time. But the expenditure of large sums of money on the improvement of mountain pastures by any method yet conceived whether it be liming and slagging with or without ploughing and reseeding is unprofitable in the end unless the increased food material so produced is either completely consumed on the spot by stock transferred to the hills in the summer time or else conserved for feeding the increased population which these improved swards are capable of carrying. If little or none of this material can be conserved then some other provision must be made for utilising the increased production. If some method of utilisation is not devised then no useful purpose has been served by the expenditure of capital on ploughing, reseeding, liming, slagging, etc. Provision must be made therefore for the wintering of these animals. Where can this winter material be produced? The areas which can make the greatest contribution include the so-called marginal farms in England and Wales, and in Wales there are large numbers of them. Here capital will be needed to drain, plough, manure and reseed to produce the winter food for the sheep and cattle coming off the hills in the autumn.

The effects of very severe winters upon hill flocks are impressive and well known, but it is not so widely realised that winters of less severity than that of 1946-47 have far-reaching effects upon the management of hill flocks. Thus

the winters of 1937-38 and 1940-41 reduced the lamb crop on many hill farms in Wales to 30 per cent or less.[2] There is thus no profit in expending capital on improving hill lands and no gain in attempting to improve hill flocks if the winter nutritional status and management of the flocks is such that the numbers are decimated every few years. Similarly, the improvement of hill flocks by the adoption of modern methods of breeding is impossible if it is difficult to maintain existing numbers. The fertility rate of hill flocks is so low and the hazards to which the young lambs are exposed so many that selection is well-nigh impossible, especially as the hill sheep farmer derives a considerable part of his annual income from the sale of draft ewes; it should be noted here that higher prices are received for 4-5-year-old draft ewes than for older sheep. In order that selection can be most effective culling should take place among the young sheep as well as the older, only the most suitable types being kept on as long as possible.

It was stated earlier that changes in husbandry in hill flocks had resulted in the virtual disappearance of hill wethers. This has meant an increase in the number of ewes carried; this attempted production of lamb rather than mutton, although giving a better financial return, is made difficult by the environment, including the food supply. The rate of growth of lambs under hill conditions is never as high as on lowland pastures

In the period between the last two wars many hill farms passed to the Forestry Commission and much of the sheltered areas on the hills became inaccessible to the sheep; the prices paid for such land satisfied the vendors at the time, but it is interesting to note that had the flocks been kept on their annual value in the form of hill sheep subsidy alone would have proved greater than the pre-war value of the land upon which they were running. It is possible that what have been regarded as "normal times" may never return and that the present relatively high value of hill farms may be maintained. If this is so then it may become necessary to treat the hill and marginal farms as complementary and, as has been suggested, to use the hills for summer grazing and the marginal areas for the production of winter food. In assessing the part played by hill sheep in the production of mutton it is important to realise that of all the mutton produced in three of the counties in West Wales three-quarters is of hill origin.[3]

Throughout this article the importance of winter nutrition in relation to the health and production of farm stock has been stressed. The provision of sufficient food for all classes of farm animals has always been a major problem—this is particularly true in relation to protein. Fortunately the time when it was necessary to kill off all except the breeding animals at the commencement of each winter has passed but it is still true that the provision of adequate supplies of winter food of good quality is a problem of great urgency. In the years before the last war the protein available for home-grown crops could be supplemented with supplies of imported oil cakes, but this is not possible now and may not be for many years. It becomes essential therefore to concentrate attention

upon husbandry methods which will help to attain the amount of food needed for health and maximum production.

The opinions expressed in this paper may be disputed, but the writer does not believe there are any practical difficulties in the way of their adoption; their adoption, however, involves the expenditure of capital and they will not be carried into effect unless the farming community has confidence in the future of the farming industry. The importance of these economic considerations cannot be minimised, but it is suggested that they should not be allowed to influence unduly the thinking and planning of the veterinary profession in relation to problems of health and disease control.

Summary

(1) The expansion of the ley farming system to foster the cultivation of cruciferous crops and leguminous crops, particularly lucerne in dry climates, and certain strains of indigenous and pedigree clovers and such grasses as rye and Italian ryegrass in wet areas will contribute to a lengthening of the growing period.

(2) The extension and development of rotational grazing paddocks within the system of ley farming will give scope for improvement in pasture management, leading to maximum production and the maintenance of swards of high quality. The piped water supplies, essential to a well-managed grazing paddock, should play an important part in reducing the spread of enteric diseases.

(3) There is room for the extension of ensilage and grass drying. These are of primary importance in all areas but have a special place in the west country, particularly in areas of high rainfall. The development of grass drying on a communal basis as in the Gower peninsula in 1948 and the marketing of a cheap portable grass dryer are of particular importance in areas where the holdings are small and already over-capitalised; similarly, the invention and manufacture of silage-making machinery for small farms is a matter of urgency.

(4) There is scope for a greater degree of specialisation in cattle rearing so that the young animals can receive special attention upon farms where the whole farming economy is designed for the rearing, feeding and housing of young stock and where it would be possible to develop and apply preventive measures against disease, bacterial and helminthological in origin.

(5) It is suggested that the so-called marginal areas should be developed for the purpose of producing and conserving food for cattle and sheep for consumption during the winter when they are brought down from their summer hill grazings.

REFERENCES

(1) McMeekan, C. P. (1947): "Pasture and Animal Production," *Proc. Sev. Ann. Con. New Zealand Soc. Animal Prod.*, 13-27.

(2) Griffiths, Moses: "Sheep." Faber and Faber, London.

(3) Phillips, R. W.: Personal Communication.

TRICHOMONAS VAGINALIS OF MAN

By W. McKIM H. McCULLAGH, F.R.C.S., F.R.C.O.G.
London

HAVING spoken to several veterinary surgeons who are investigating trichomonas fœtus in cattle and having found all of them interested to hear of the effect of trichomonas vaginalis in man, I am writing a short article on the disease in women, hoping it will be found interesting and instructive.

To begin with, I must confess that I find the knowledge of trichomoniasis is more widespread amongst veterinary surgeons than amongst the medical profession, although it is over 100 years ago since human trichomoniasis was first discovered. This is possibly due to the fact that vaginitis in women can also be caused by gonorrhœa, *Monilia candida,* Bacillus *coli* and Vincent's organisms. The human disease certainly should receive more attention than it is getting at present, as I find that 11 per cent of my private gynæcological and 15 per cent of my hospital cases are infected. Some 60 per cent. of vaginal discharge cases and 42 per cent. of female gonorrhœa cases have T.V. These figures will astonish the veterinary profession, and especially so when they find that many medical men still look on the organism as a normal inhabitant of the vagina. Trussell, an American, has recently published an interesting book on the human infection, in which he states that he reckons that no less than 10,000,000 women are affected in the U.S.A. It is not a venereal disease in the human. Only 5 per cent. of the husbands of infected wives are carriers of the organism. I consider the 90 per cent. source of infection in women is frequently-used lavatory seats in hotels and boarding-houses; the anterior edge of the seat, if wet, with discharge from an infected woman, could infect several subsequent users before it becomes dry.

As in cattle, the affected vaginal wall in acute cases often presents a glazed surface or one with strawberry-red erosions. A greenish-yellow discharge with a frothy appearance is most common.

The diagnosis is made by examining a fresh drop of the discharge with the microscope within a minute or so of it being taken. The oat-shaped organism with its jerky motions caused by its flagellæ settles the diagnosis. They are most active after a period or when blood is present, as, for instance, in infected women after a miscarriage. T.V. is a more delicate organism than T.F., more easy to kill and more difficult to culture. It is found very seldom inside the neck or body of the womb or its tubes; in almost all cases it is confined to the vagina, but in some cases recurring after treatment I have found it in the urethra and anal canal.

The troubles caused to women by this infection may be almost nil, but more generally it is found to be a cause of chronic ill-health. I consider it to be the commonest unsuspected cause of ill-health in women to-day.

The most common symptoms are heavy periods, resulting in fatigue, pallor, headaches, attacks of giddiness, loss of sex desire and marital unhappiness. Nightly frequency of micturition occurs in those where the urethra is infected. Pruritus or itching of the vulva is not uncommon. Pelvic pains and backaches

are frequent complaints and are often associated with internal adhesions around the tubes and ovaries. Mental fears and phobias are also occasionally complained of and treated psychologically without success. The old and the very young may be affected; my oldest case was aged 76. Miscarriages are not markedly associated with trichomonas infection as they are in cattle. Wasting does not occur; in fact, not infrequently there is an increase in weight owing to a dropsical condition of the body. Frequently there is loss of energy and marked pallor due to anæmia. Sterility is not associated with the infection in women.

It will thus be seen that although microscopically the human and bovine organism seem to be almost indistinguishable, yet the signs and symptoms of the disease differ considerably in the two hosts, or rather hostesses.

Treatment to be effective must be continuous. Douches are useless. Arsenic seems to be the only effective drug in the form of pessaries of Stovarsal, Biarsenalic acid, Carbarsone, Devegan, etc. I find that insufflation of powder with the insertion of pessaries high up in the vagina each night for six weeks leads to resolution in 90 per cent. of my cases.

Recurrent cases need more intensive treatment, including oral medication.

General Remarks

(1) Trichomonas infection in women is a not uncommon source of unexplained ill-health.

(2) Gynæcological examinations to be complete should include a test for this infection as many women have no local symptoms to indicate infection.

(3) Gynæcological operations not infrequently fail to cure completely because this cause of vaginal sepsis and bladder infection has not been discovered and treated.

(4) A patient, if free of infection three weeks after treatment and again three months after treatment has ceased, can be regarded as cured.

THE SENSITIVENESS OF PATHOGENIC STAPHYLOCOCCI ISOLATED FROM ANIMALS TO PENICILLIN

By H. FARRAG, B.V.Sc., M.V.Sc.(Cairo), Ph.D.(Kansas)
Department of Bacteriology, Cairo Veterinary College, Egypt

IT is well known that staphylococci as well as other penicillin-sensitive organisms develop resistance to penicillin. It is influenced by the indiscriminate use of the drug, and since very little has been recorded about this in veterinary literature, a record is given herewith of a study of the sensitivity of pathogenic staphylococci isolated from different animals and of an attempt to increase the resistance of one of the strains to penicillin.

Method

Staphylococci were isolated from abscesses and septic wounds in horses and donkeys, mastitis in cows and otitis media in dogs. All the cases were brought either to the Royal Society of Prevention of Cruelty to Animals of Cairo or the Veterinary College Hospital and none had received penicillin.

The *in vitro* sensitivity of the organisms to the action of penicillin was determined by streaking an inoculum of a standard loop of a 24-hour broth culture on agar plates containing known units per c.c. of penicillin. Three cultures were tested on each plate and all plates were incubated for 24 hours at 37 deg. C. The results are as follows:—

Culture No.	Control	Concentration of penicillin (unit per ml.)									
		0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.1
1	+	+	+	+	+	—					
2	+	+	+	+	—						
3	+	was only inhibited by 0.5 unit									
4	+	+	+	+	+	+	+	+	+	+	—
5	+	+	+	+	—						
6	+	+	+	+	+	+	+	+	+	+	—
7	+	+	+	+	—						
8	+	+	+	+	+	+	+	+	+	+	—
9	+	+	+	—							
10	+	was only inhibited by 2 units									
11	+	+	+	—							
12	+	+	+	+	—						
13	+	+	+	+	+	+	+	+	+	+	—
14	+	+	+	—							
15	+	+	+	+	+	+	+	+	+	+	—
16	+	+	+	+	+	—					
17	+	+	+	+	+	+	+	+	+	+	—
18	+	+	+	+	—						
19	+	+	+	—							
20	+	+	+	—							
21	+	+	+	+	+	+	+	+	+	+	—
22	+	+	+	+	+	—					
23	+	+	+	+	—						
24	+	+	+	+	+	+	+	+	+	+	—
25	+	+	+	—							

All the cultures were hæmolytic *Staphylococcus aureus* except Nos. 2, 6, 11 and 22 which were *Staphylococcus albus*.

The results can be summarised as follows:—

6 strains inhibited by 0.03 units per c.c.
6 „ „ „ 0.04 „ „ „
3 „ „ „ 0.05 „ „ „
8 „ „ „ 0.1 „ „ „
1 strain „ „ 0.5 „ „ „
1 „ „ by as much as 2 units per c.c.

The resistance to penicillin of the last strain (No. 10) is more than 60 times that of the most sensitive strains; it was isolated from a case of otitis media in a dog whose owner denies having used penicillin for himself or his household.

Artificial Development of Resistance to Penicillin

One of the sensitive strains which was inhibited by 0.03 unit per c.c. (culture No. 9) was chosen to study the development of resistance to penicillin by sub-culturing it in the presence of increasing amounts of the antibiotic. In this way its resistance to penicillin was increased as much as 220-fold. The highest concentration in which this strain could be grown was 6.6 units penicillin per c.c.

Discussion

Increased resistance to penicillin by staphylococci from human sources has

been described by several investigators. Most of them have attributed this increase in resistance to the indiscriminate use of penicillin in the treatment of human infections.

Apparently this has not occurred yet in animal diseases, at least in this country; since this drug is becoming more available and cheaper, its use in the treatment of animal diseases is expected to become more common in the future and what has happened in human medicine will also occur in veterinary medicine. On account of its restricted use in veterinary practice in this country, there has, as yet, been no opportunity to study naturally occurring resistance to penicillin of pathogenic staphylococci isolated from animals. The results obtained by artificially induced resistance suggest the possibility of the natural increase of resistance to penicillin in veterinary practice.

Summary and Conclusion

1. With the exception of strain No. 10 which was only inhibited by 2 units penicillin per c.c., all of 25 strains isolated from pathological lesions in animals were found to be penicillin-sensitive.
2. Resistance could be increased artificially as much as 220-fold, and this suggests the possibility of naturally occurring resistance to penicillin by staphylococci encountered in veterinary practice.

Acknowledgment

I wish to express my thanks to Dr. M. A. Gohar, Professor of Bacteriology, Faculty of Medicine, Cairo, for his suggesting this piece of work and for his guidance and help.

REFERENCES

(1) Dawson, M. H.: Penicillin sensitivity of non-hæmolytic streptococci isolated from cases of sub-acute bacterial endocarditis. *Soc. Expt. Biol. & Med. Proc.*, 56: 101-102, 1944.
(2) Rammelkamp, C. H., and Maxon, T.: Resistance of *Staphylococcus aureus* to the action of penicillin. *Soc. Expt. Biol. & Med. Proc.*, 51: 386-389, 1942.
(3) Spink, W. W., and Vivino, J.: Comparative *in vitro* resistance of staphylococci to penicillin and to sodium sulfathiazole. *Soc. Expt. Biol. & Med. Proc.*, 55: 207-210, 1944.
(4) Doll, E. R., and Dimock, W. W.: Penicillin dosage and blood levels for horses. *Am. Vet. Med. Assoc. Jour.*, 108: 209-214, 1946.
(5) Barber, M.: Staphylococcal infection due to penicillin-resistant strains. *Brit. M. J.*, 2: 863 (November 29), 1947.

CLINICAL ARTICLES

TREATMENT OF CANINE HYSTERIA BY RAW LIVER

By DAVID J. ANTHONY

Since canine hysteria first came prominently before the veterinary profession, like others I have had a number of patients to prescribe for. I have always noted that these cases are invariably found in animals fed on a diet deficient in meat offal. The kind of "meat" diet usually given to dogs from pet shops usually consists of muscle tissue cooked until most of its nourishing properties have vanished. It is also noticeable that when people speak of having given their dogs "meat," they usually mean portions of muscular tissue, gristle and bones. The war years and the post-war rationing system has made

it almost impossible for many people to provide the necessary carnivorous diet for their dogs, hence the great increase in biscuit feeding and hysteria.

Not being in general practice, the dogs I have to prescribe for are either valuable gun dogs or perhaps more valuable, although less well bred, working shepherds' dogs. Treatment consists in taking the animals completely off any biscuit meal and giving an exclusively carnivorous diet consisting of either (a) boiled liver, cut up into small portions when cool and dry—the liver being condemned meat, selected so that it does not contain visible disease lesions, and boiled until it is cooked throughout; or (b) in place of liver, cleaned and boiled sheep paunches (rumen and reticulum) can be substituted and is equally efficient.

This is fed to the animal, and the only medicinal treatment consists of about a tablespoonful of raw, minced liver soaked in cod-liver oil, fed twice daily. Feeding these hysteria cases in this manner for two or three days, or a week, depending on the severity of the case, usually results in an almost miraculous change in the patient. Dogs that are rather poor in condition and listless become full of vim after a week's treatment.

I never prescribe nerve sedatives, as no matter how often a dog has these hysteria attacks they tend to diminish as the liver treatment progresses, both in their severity and the number of spasms. Depriving the animal of any agenised meal is not the key to the success of this treatment, as I have fed dogs on biscuits *in addition* to the offal.

The rationing system makes it impossible for many practitioners to adopt such a treatment as I have described, but I would commend to them the value of liver extract or desiccated pig stomach extract for the treatment of canine hysteria.

ATTEMPED TREATMENT OF FIBRO-ADENOMATA IN THE BITCH

By DAVID J. ANTHONY

THE treatment of mammary tumours in the bitch by injections of colchicum or by stilbœstrol is a recognised veterinary practice, and has met with varying success. The case recorded here is one of the unsuccessful ones and is mentioned chiefly because the nature of the tumours treated is known.

The bitch was an eight-year-old golden spaniel, kept as a pet and never been mated. Seven tumours in all gradually appeared in the mammary glands, all posterior to the umbillical region. The tumours seemed to cause no pain or discomfort to the animal, although the largest measured 36 mm. across. The remainder were much smaller, measuring 10 mm., 12 mm., 14 mm., two of 15 mm. and one 16 mm. The owner was loath to allow surgical interference, but consented to medicinal treatment.

Injections of 1/40th mlgm. colchicum in 1 c.c. of sterile water, with three-day intervals, gradually increasing the dose in the usual manner until 1 mlgm. was reached. The tumours were measured every third day, and finally about a month after the final injection had been made. No change was found in the measurements.

A month later, treatment with oral stilbœstrol in tablet form was commenced, and continued for three months, with no appreciable effect on the size of the tumours.

The animal developed a femoral hernia some months after the tumour treatments had been discontinued and the owner eventually requested that the dog be destroyed. I obtained permission to remove the mammary tumours under a general anæsthetic and to destroy the bitch by an overdose.

The mammary glands so removed were sent for examination to the Birmingham Medical School, and the pathological report on the tumours describe them as having the basic structure of fibro-adenoma, but with great morphological variation, including in some places intracystic papilloma formation, mucoid degeneration and areas of pseudocartilage. In two of the tumours there appeared to be some histological evidence of malignancy, although the great variability in structure of these tumours made it difficult to be at all certain. In many cases the fibrous stroma was very active and cellular.

REVIEW

The Right Way to Pig Keeping and Breeding. By ALAN MORLEY. Right Way Books. Price: 5s.

THIS little book represents an attempt to provide in concise form a comprehensive guide to the breeding, management and feeding of pigs and, according to the foreword, it "was written to serve the practical man, but is of special value to beginners and students."

Whilst there is contained within its pages much that is sound and practical, the possible value of the book is considerably reduced by a number of misstatements and by the omission of several matters of which mention might properly be expected in a text of this kind. As an example of the former, page 13 bears the following passages: ". . . the immediate parents contribute a quarter each of the germ plasm of their offspring and the four grandparents one-sixteenth part each," and "In the case of cattle, when each female produces only one offspring per year, the bull is truly 'half the herd,' but in pig breeding the multiple births make the sow proportionately more important as an influence on future stock."

The description of castration is open to criticism (not least because of the implication that it should be done in the presence of the sow), whilst the chapter entitled "Health and Disease," which ignores, amongst other things, swine erysipelas, is clearly inadequate in the information it would convey to even the beginner at pig-keeping. Other examples of inaccuracy or of incompleteness could be cited in every chapter. These will be obvious enough to any informed veterinary reader into whose hands the book may come: we are only concerned here to point out that, for reasons already indicated, it cannot be recommended to students.

G.A.W.

Publishers' Notices

THE BRITISH VETERINARY JOURNAL, with which is incorporated THE VETERINARY JOURNAL, is published monthly, and copy for advertisements should be in the hands of the publishers—Baillière, Tindall and Cox—not later than the 20th of the preceding month, if proof is required. Tel.: Temple Bar 3386.

Letters for the Journal, literary contributions, reports, notices, books for review, exchanges, new instruments or materials, and all matter for publication (except advertisements) should be addressed to the Editor.

Annual Subscription, 30s. ($6.50 U.S.A. currency, post free.)